

STATE ENGINEERING EXPERIMENT STATION

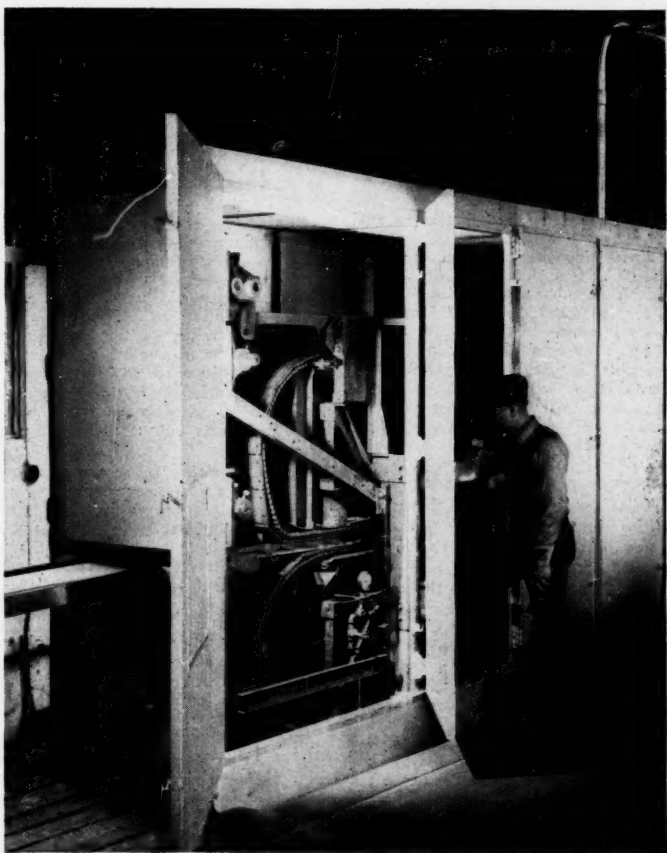
# The Research Engineer

GEORGIA SCHOOL OF TECHNOLOGY

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# The Research Engineer

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## TECHNICAL WRITING

It has long been realized that many engineers and scientists are particularly inept when it comes to translating their thoughts and work into writing. This failing is far more serious than humorous, for the technical man's lack of ability—or interest—in the proper recording and reporting of his experiments too frequently yields inadequate notebooks, skimpy and poorly written progress reports, final reports that are not complete analyses of the data actually recorded, and journal articles that are only slightly informative and that require extensive editorial rearranging.

While few scientists or engineers are publicity hounds, most of them are properly interested in having their work reported in at least the proper scientific journals. When it comes to the actual preparation of the articles, however, all too few of them take enough time to analyze the exact significance of their data; arrange the description of equipment, tests, and results in a logical fashion; and present all this information in a concise form calculated to fit the editorial needs of the journal selected—needs predicated upon the wants of the journal's regular audience. All too often, also, the scientist becomes discouraged by the very thought of writing and fails to report his work at all, to

the detriment of the storehouse of scientific information.

Engineering schools, in recent years, have been struggling valiantly to overcome the average student's antipathy to proper and adequate use of the King's English. Numerous books on technical writing have appeared. Scientific organizations have taken steps to systematize their report requirements, several even employing editors to aid in this work. Enlightened managements have encouraged their scientists to report the publishable aspects of their significant research.

In the planning of any research or technical program, time for writing should be definitely provided. The technical man should come to feel that the reporting of his work is of equal importance to its performance and not a task to be hastily completed—and then only because it is required. The English language is reputedly one of the world's most difficult, but it does not take the language command of a Shakespeare to write on a subject which should be well within the comprehension of each particular researcher.

The engineer and scientist must come to realize that his work is of permanent value to few if it is not recorded, and that its usefulness is greatly diminished if clear, logical English is not employed in its description.

# TVA RESEARCH AND AGRICULTURAL ENGINEERING ACTIVITIES

By JOHN C. SLACK\*

*Georgia Tech and other units of the University System of Georgia have played a significant role in the important research activities of the Tennessee Valley Authority, as is evidenced by the cover of this issue which shows the TVA continuous glue press for laminating lumber from cull hardwoods, originally developed and built here at the Engineering Experiment Station of Georgia Tech. This is the second of two articles on the functions and activities of the TVA Commerce Department, the first article having appeared in the last issue of this journal.*

## REGIONAL PRODUCTS RESEARCH

The Regional Products Research Division of the TVA Commerce Department conducts research relating to the local processing of the region's farm, forest, and mineral resources, and engages in surveys of mineral resources. This division secures commercial application of new products and processes and renders technical assistance to business in the fields of mining and refining minerals, processing of foods, woods, fibers, and oil-bearing seeds. The functions of the division are carried out in collaboration with state colleges of the area, especially the engineering experiment stations, and with other state and federal agencies.

### Food Processing

In the Tennessee River watershed and the TVA power service area, public research has had a more direct influence on the frozen food industry than is usually the case. TVA may be primarily responsible for this, because of its practice of collaboration with other agencies and institutions which has led to an interchange of information which is made available to operators and proposers of commercial freezing and freezer locker plants.

TVA's entry into food processing research was occasioned by the need of strawberry growers in an East Tennessee area for an orderly method of marketing their fruit, to avoid the losses and waste caused by seasonal gluts. The initial attack on this problem was undertaken jointly with the University of Tennessee, and it laid the basis for a thriving commercial freezing industry throughout the Valley. Continuing research activity in this field is helping TVA to carry

out its duties in promoting the use of fertilizers and electric power, protecting the watershed, and effecting a more complete and better balanced development of the resources of the region. The importance of this research and the widening of its range have grown with the rapid gain in popularity of frozen foods.

In 1938, the Georgia Agricultural Experiment Station (under the direction of Dr. H. P. Stuckey) and the TVA Department of Agricultural Industries (later combined with the Commerce Department) began a project concerned with the microscopic study of frozen foods. Under a master contract made in 1939 with the Regents of the University System of Georgia, the Agricultural Experiment Station and other units of the System have conducted research, studies, and experiments relating to the development of a process for the quick freezing of fruits and vegetables, including (but not restricted to): "determining the suitability of different varieties of fruits and vegetables for quick freezing; the effects of freezing methods on different varieties; blanching methods; microscopic and bacteriological changes in various stages of quick freezing process; packaging requirements; methods of peeling peaches to be quick frozen; methods of preventing 'browning' of peaches and apples in all phases of quick-freezing process; quality standards; and standardization of tests for quick-frozen foods." This contract has been extended and amended from time to time, and work has included assembling factual information for the use of the United States Department of Agriculture in construction of standards for grades of various processed foods. Studies made at the Agricultural Experiment Station to the present include freezing of fruits and vegetables, utilization of peanuts, control of food spo-

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liation, and dehydration of foodstuffs. The project on freezing is still active.

The Agricultural Engineering Department of the University of Georgia began a cooperative project in 1945 involving investigation of "engineering problems in connection with the design, installation and operation of community food processing plants and related facilities for preserving food by canning, freezing, dehydrating, pickling, curing, and storage." A standard design for community locker plants has been completed, and one plant has been built according to this design. This will serve as a pilot plant, and instruments have been installed in it for the purpose of obtaining complete operational data.

The first cooperative project related to food processing which TVA has had with the Engineering Experiment Station of the Georgia School of Technology was started in December, 1945, for the purpose of conducting research leading to the development of the most effective method of freezing preservation and the design of equipment therefor. This project was extended last year to provide for preparation of "a manuscript of abstracts of developments in the frozen food industry, suitable for publication, which will contain the results of literature studies obtained as the result of the cooperative effort of TVA and the Regents of the University System of Georgia." The latter portion of the project has been completed, and this work has been published under the title "Literature Search on the Preservation of Foods by Freezing," Special Report No. 23 of the State Engineering Experiment Station. The part of the project relating to the engineering problems confronting the freezing industry continues.

Thus Georgia institutions have contributed much in the way of basic investigations related to the region's food processing program. The industry development and process commercialization phase of the program is centered at TVA's mobile pilot plant, on barges at present afloat on Watts Bar Lake, near Spring City, Tennessee. This activity is conducted for the purpose of encouraging development and efficient operation of rural plants by supplying engineering information and technical guidance based on studies conducted by TVA and Valley institutions. Formulation of standards for grades of fro-

zen foods is also undertaken in this phase of the program. During the latest fiscal year, TVA and cooperators furnished a variety of technical and economic information for eight commercial freezing establishments and for most of the freezer-locker plants which are established in the Valley.

#### Wood Utilization

To complement the region's conservation and development programs and, specifically, to promote scientific forestry practices such as selective cutting, the Regional Products Research Division undertook a study suggested by the U. S. Forest Products Laboratory. Under the master contract with the Regents of the University System of Georgia, a project was entered upon in 1940 "relating to the development of processes and apparatus capable of using cuttings from cull timber and cord-wood-size hardwood in the fabrication of three-ply lumber." At the Engineering Experiment Station of the Georgia School of Technology, a hydraulic gluing press was developed into which slats from cull hardwoods are fed; there emerges from this press a continuous strip of laminated lumber, one-foot wide, which can be cut into any desired lengths.

With the cooperation of the Engineering Experiment Station and other agencies and institutions, refinements in the process and equipment have been made from time to time. The laminated lumber experiment has been carried successfully through the pilot plant stage at Knoxville, Tennessee, and the operation has been turned over to a new company formed to test it under commercial conditions.

#### Flax Research

Last year, in cooperation with the Engineering Experiment Station of the Georgia School of Technology, a comprehensive report was published which covers work to date on the processing of flax fiber. As early as 1936, TVA began a joint study on the growing of flax with the Georgia Agricultural Experiment Station, which study continued for several years. TVA research looking to the development of methods and machines for processing the material so that it could be spun and woven on cotton mill machinery, also begun in 1936 and later placed in the hands of the Engineering Ex-

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## INVENTION RECORDS

By B. H. WEIL\*

*If patents, when obtained, are to be valid, careful attention must be given at all stages of inventive development to the keeping of adequate, authenticated records. While legal requirements for such records are stringent, they are relatively easy to follow, and this article is intended as an outline of acceptable procedures. It is the second of a series of articles on patent technology designed primarily for the engineer and industrialist.*

Patents, to be valid, must do more than describe a concept or mechanism which has never before been patented. All too often in this age of business speed, the inventor, intent on completing and marketing his device or process, fails to keep adequate records of his mental processes and laboratory or shop operations.

In the average case, if the inventor is lucky, this may not matter, since there is no need for a record of dates in the prosecution of a patent application which does not meet with "interference" in the Patent Office—the latter happens in about four per cent of all cases. In the exceptional case, however—and no inventor can predict that his invention will not fall among the sizable number of exceptions—these records are of incalculable value, for without them he cannot legally establish, on a firm basis, any invention date prior to that of the filing of the patent application. In patent cases, verbal testimony and unauthenticated documents carry very little weight when compared with properly witnessed records.

### NEED FOR RECORDS

There are at least two occasions on which an inventor may be called upon to prove the dates of his invention:

1. If, upon or during application for a patent, the Patent Office finds that an application from another person covers the invention at least in part, it institutes "interference proceedings," during which each party must show his dates of invention, and then awards the decision, not necessarily to the inventor who files his application first, but rather to the inventor who can prove the earliest invention date; or

2. If, after the inventor has been granted a patent, he finds and warns an infringer thereof, and finally institutes legal action against that infringer, he may have to prove his invention dates to refute charges of invalidity because of some prior publication of which neither he nor the Patent Office was aware and which predates his date of filing of an application; if his records can show that this publication came after his conception date, he can save his patent from being ruled invalid (and thus unenforced) for want of invention.

There are many variations and corollaries of these cases; for example, an inventor may find that the Patent Office has issued a patent which completely describes an invention upon which he has been working diligently for several years, yet on which he has not filed patent application for good and sufficient reasons. If, after consideration of the other inventor's filing date (which appears on each patent), the inventor believes that he can prove that his date of conception preceded that of the second inventor, he can file a patent application which duplicates all of the claims of the issued patent and, *if he can prove diligence and secrecy as well*, can have a patent issued to himself which effectively gives him all rights and invalidates those of the other patentee.

The most important reason for keeping adequately authenticated records, however, is that these records will then be available if some unscrupulous individual or company learns of an invention on which an application has not yet been filed and attempts to patent it as his own. If good records are available, they will enable the real inventor to win the interference contest that will inevitably arise when he does file a patent application.

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There is much more to the pre-patent period, of course, than the mere keeping of records. The inventor must make certain, by an adequate search of prior patents and literature and by taking proper precautions, that his invention was (in the words of the patent laws): (1) "not known or used in this country before his invention and discovery thereof," (2) "not patented or described in any printed publication in this or any foreign country, before his invention or discovery thereof or more than one year prior to his application," (3) "not in public use or sale in this country for more than one year prior to his application, unless the same is proved to have been abandoned."

The significance of these legal requirements is self evident; the inventor must be certain, after assuring himself that his inventive concept is unique and useful, that he does not publish any description of his invention or put it on sale or in public use more than one year before he applies for a patent. Experimental use does not fall within these restrictions, so long as the user is informed of the purpose of such use and is requested to refrain from revealing the confidences given him. Under such circumstances, sale of the article to the user is usually a poor idea unless adequate records authenticate that the user's use is experimental and confidential and that his ownership (by purchase) is merely coincidental and at least temporarily confidential.

Many of these subjects, and others, will be commented upon in more detail in future articles of this series, but it is now timely to turn to a discussion of invention records and procedures for their maintenance.

#### NOTEBOOKS

In the performance of research on any invention, it is of the utmost importance that notebooks be properly *kept* and *used*. Data recorded on scraps of paper, loose-leaf sheets, etc., have no legal value whatsoever unless each is signed, dated, and witnessed. A sound procedure includes the following items:

1. A rigidly bound notebook should be used, not a loose-leaf or spiral bound book into which additional sheets can be inserted or occasional sheets removed. In such a book, pages should be numbered consecutively; none should be skipped during use; and the

whole of both sides of each sheet should be used. Where at all feasible, separate notebooks should be employed for different projects.

2. Entries should be made in ink or indelible pencil, unmistakably identified (signed by the individual making the entries), dated, and witnessed. Pages should be dated at the top when begun and signed and dated at the top when finished. Dates should not be abbreviated, and all signatures should be in the usual form employed by the individual. Cross out unused portions of completed pages.

3. When work is begun on a project, the first entry should be a statement of the problem and the proposed mode of attack.

4. Sketches should be made of all important apparatus or mechanisms, showing essential parts, connections, and the relative size or capacity of the elements.

5. All operating details and variations should be mentioned, such as those for chemical processes — reagents, temperatures, pressures, time required, yields, etc. These data should be complete and not entrusted to the memory of the experimenter.

6. All calculations, observations, and conclusions should be carefully recorded. The apparently trivial factor in one experiment may be very important in another.

7. Results should be explained, in spite of the familiar statement that figures speak for themselves.

8. Practices which arise from thoughtlessness should be avoided, such as broad statements that experiments were unsuccessful and the use of such "categorically negative symbols as 'NG' for 'No Good.' A letter 'R' marked across a page to indicate that the data have been reported can be twisted to mean 'Rejected.' Erasures and other modifications which might appear to have been made at a later date should be avoided;<sup>1,2</sup> errors should be crossed out, not erased. Coined names and trade names for materials and articles should not be used without chemical or functional identification. Negative results are often as important as positive results; therefore, when such results are obtained, an explanation should be given if possible. For example, phrases such as "the

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## FROZEN FOODS FROM A RETAILER'S VIEWPOINT

By L. J. ROSENBERG\*

*Georgia Tech research on frozen foods is but part of a general movement in this area toward increased attention to frozen foods. Chief interest here is centered in the actual preservation of perishable crops and the establishment of markets for new frozen food products, but on the horizon of all such developments is the final necessity of seeing that the foods are sold. This effort has not been too difficult in the past, but, as the author of this paper (a Georgia Tech alumnus with actual experience) points out, there are barriers ahead with which to reckon. Economic and business information are an inseparable part of technical process development, and it is for this reason that the following article is of considerable significance.*

The retailer is the man on the firing line in the merchandising of frozen foods. His is the task of selling the ultimate consumer—the average housewife—both an idea and a product. On his success depends the future of the frozen foods industry.

In the merchandising of products such as frozen foods, the retailer must at present be an educator, cooking specialist, and nutrition expert, plus a good salesman, because the majority of housewives have not as yet been completely educated in the use of frozen foods.

What is often forgotten, however, is that the retailer is in his store for one reason only—to sell, in order that he may realize a profit on his operations. Basically, he does not care what he sells, be it frosted foods, canned goods, or fresh produce. His job is to supply the customer with her wants—then he can ring up the cash register.

About all that the average grocer can now gain by the handling of frozen foods is protection against any tendency of his customers, if he does not carry frozen products, to do their marketing at some other store that does. Few retailers, at present, can do enough volume selling of frozen foods to make this operation carry its share of the overhead.

The independent food store, which does 66 per cent of the total food business of the country, must necessarily prove to be the mainstay of frozen foods retailing if real volume is to be achieved, for frozen foods

will become staple items only when they are everywhere available. In certain metropolitan cities, however, frozen food specialty stores have done a thriving business, but their success, to date, has been chiefly caused by the offering of a wide variety of precooked dishes and other frozen novelties, in addition to fulfillment of demands created by the shortage of certain foods—demands which began during the war years and which were artificially prolonged by the price control system.

Frozen foods are also sold by the large grocery chains, supermarkets, and department stores, and there are even house-to-house delivery systems. All this activity is ample evidence that there is a wide-spread interest in frozen foods on the part of the retailer, but if frozen foods are to attain an important position in the grocery field, it will be because they become a staple grocery item, not a novelty product demanding a fancy price. To effect this, the packer must do several things: he must lower his unit prices, improve the quality of his pack, and improve the appearance of the varieties to be packed and the containers in which the foods are sold.

### RETAILING NEEDS

As far as the retailer can tell, continued research is apparently needed to develop varieties more suitable for quick freezing. The product should present an attractive appearance when the container is opened by the housewife. Varieties chosen for freezing

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must be especially selected in order that top quality be always maintained.

One handicap faced by the retailer is that the public has been subjected to a barrage of inferior products packed under a variety of unknown labels. Having been "stuck" several times, Mrs. Housewife hesitates to purchase frozen foods again. The frozen foods packer must clearly understand, for his own sake, that the consumer of frozen foods wants only one quality: the best. The consumer must have complete confidence in the brand name of the product she buys. Supplies must also be ample, so that the grocer is never forced to be out of staple frozen food merchandise.

It is important that brand names be well advertised, so that consumers, after becoming acquainted with their quality, will learn to call for them by name. Nation-wide advertising is the only possible answer to this

aspect of the retailer's problem. More newspaper, magazine, and radio advertising is essential if the demand for frozen food is to continue to expand, and such advertising should be done by those who sell to the retailer, not by him.

Various size packages should be developed, and these sizes should be standardized. There should be standards comparable to the No. 2, No. 5, and No. 10 cans in the canned goods industry. Present frozen food packages are not flexible enough to provide the proper size for all family units.

The packages themselves should, in many cases, be redesigned and improved, so that they better protect the contents and serve as a better salesman for the merchandise. The shape of the package should be determined by the size of the average refrigerator's freez-

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Figure 1. Modern frozen foods merchandising places increased stress on self-service, which in turn emphasizes the need for adequate package labeling and well engineered refrigerated display cabinets



## **INDUSTRIAL ENGINEERING**

*By FRANK F. GROSECLOSE\**

*Industry has become intimately acquainted with the functions and potentialities of the chemical, civil, electrical, and mechanical engineers and with specialists in such fields as aeronautical and textile engineering. To this group of engineers has recently been added the industrial engineer who, trained in engineering practice and management procedures, serves to coordinate men, materials, machines, and methods in the solution of problems encountered in the conversion and fabrication of raw materials into the products of industry. This new field and the aims and functions of the recently organized Georgia Tech Department of Industrial Engineering are described in the following article, which also discusses plans for a research program that should be of interest to industry.*

The increasing magnitude and complexity of modern industrial plants have brought into being a new branch of engineering, now widely recognized by the title of "Industrial Engineering." This field involves the planning, organizing, improving, managing, and operation of the various processes required for the production of all types of manufactured products. The practice of industrial engineering serves to coordinate men, materials, machines, and methods in the transformation and fabrication of raw materials into the products of industry.

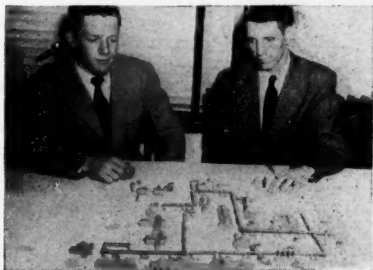
The broad function of the industrial engineer is to increase production and productivity and, at the same time, to decrease costs. Concurrently, he seeks to increase the quality of the product and improve the position of the workers. Some skeptics say that all this cannot be done, yet the last half century of American history has proved that it is already being done to a considerable extent, but with plenty of room for further improvement.

New problems have arisen and new techniques have been developed during recent years that are peculiar to and characteristic of industrial engineering. These include the analysis of a proposed product with regard to the possible steps and sequences of operations involved in its manufacture, a selection of the most efficient machines to perform those operations, the layout of the plant and shops to provide for the flow of the product from one machine to another, organization of the material supply, and the avoid-

ance or elimination of bottlenecks, together with the related problems of quality and cost control, testing, inspection, and personnel relations.

The successful industrial engineer must possess special interests and abilities in the analysis of the human, technical, and financial problems of modern manufacturing. In addition, he must possess the essential personality and attributes of character which will enable him to work with and direct others in the planning and operation of manufacturing enterprises.

Scientific management, so-called, is not a code of rules as much as it is an attitude of mind that aims to replace "I think" with "I know"; the extent to which this can be accomplished will depend on how far the principles involved can be developed quantitatively. All branches of human activity have risen above the stage of empiricism and rule-of-thumb decisions only as they have



*Figure 1. Plant and process layout are among the functions of the industrial engineer.*

\*Head, Department of Industrial Engineering.



Figure 2. Through time and motion study, the industrial engineer determines the best manner of performing the work and the time to be allowed for its accomplishment.

been able to build upon the accumulated facts of experience and the accurate conclusions drawn from them.

Industrial organizations and managements are no exception to this rule. Until quite recently, industrial management has been largely personal and empirical, rule-of-thumb methods being almost universally used in all matters. However, the need for more accurate information, especially in administering large enterprises, has led to a more careful examination of the art of management. This has been done with a view to finding whether any basic principles existed that might serve as a safer guide than the cruder empirical methods, and with the hope that a better understanding and more accurate solution of these problems would come with a fuller understanding of these basic laws.

Such basic laws do exist, and the term "Industrial Engineer" is becoming synonymous with one skilled in factory design, organization, and operation, who endeavors to rest his conclusions, not on simple empirical information or judgment, but, as far as possible, upon basic proved facts. The scientific method that involves observation and recording of the data of the phenomena concerned, then deduction from these data of the fundamental laws of the phenomena, and finally application of these deductions to predict other results, has come to stay in all lines of human activity.

Just as the design engineer endeavors to obtain highest efficiency by eliminating energy losses, so the industrial engineer is a close student of wastes in manufacturing

processes. Just as the design engineer seeks to rest his work on accurate data and scientific facts, so the industrial engineer seeks to observe, record, and formulate the data of industrial operations and industrial management in order that he may accurately predict the results of other operations and arrangements. His field is indeed a wide one, ranging from the collection of statistical data of an industry as a whole down to the shipping of the factory product, and his sources of knowledge have their roots in engineering, economics, psychology, and other fields of human experience. These relations and conditions apply, in general, to all forms of industry, but they apply with special force to industries having congregated labor, such as is found in manufacturing plants.

The industrial engineer's place is at the center of the industrial production process. His duties include the command of materials and equipment, on the one hand, and direction of labor on the other. Thus he is concerned with all three factors of production: materials, machines, and men. Through his efforts, the productive process is carried on with economy and dispatch; materials are available when and where needed and in the required quantity and quality; equipment and tools which are adapted to the work to be done and which are of the necessary capacity are ready when and where required; and a trained labor force under adequate supervision is on hand to do the work.

The industrial engineer determines the best manner of performing the work and the time to be allowed for its accomplishment by the techniques of motion and time study. This information is used for estimating costs, for controlling production, and for setting delivery dates. It is also used for fixing tasks which workmen are to perform and as a basis for wage payment.

The personnel—the men who operate a factory—are far more important than its building and equipment. The industrial engineer is closely associated with their administration. It is necessary for him to find the most suitable men, place them in the jobs for which they seem best fitted, train them to make the best use of their ability, and develop in them a spirit of loyalty and cooperation.

Since successful manufacturing is based on good business methods, the industrial engi-

neer frequently comes into contact with commercial practice. His work deals primarily with technical questions, but these are so closely allied to economic considerations that his decisions are based as much upon the principles of good business as upon those of sound engineering and science.

#### UNDERGRADUATE CURRICULUM

To be able to satisfy these varying responsibilities, the industrial engineer must be technically proficient and able to train and lead men. At Georgia Tech the following undergraduate course of study is followed:

##### Subjects Fundamental to Training in Engineering

Mathematics, including algebra, trigonometry, analytical geometry, and differential and integral calculus.

Physics for engineers—a complete basic course, including laboratory.

General chemistry, including laboratory.

English composition, literature, public speaking, and report writing.

Mechanical drawing and descriptive geometry.

Analytical mechanics and mechanics of materials, including the testing of materials.

Fluid mechanics—hydraulics and the flow of fluids.

Elementary surveying.

Thermodynamics and heat power, including laboratory.

Principles of electrical engineering, including laboratory testing.

Principles of economics.

Shop experience in the fundamentals of wood-working, welding, pattern-making, foundry, and machine shop practice.

Fundamentals of industrial design.

##### Subjects Fundamental to Training in Industrial Engineering

An introductory course in industrial organization and administration.

A sequence of courses dealing with the methods of manufacturing, including the engineering of tools, jigs, and fixtures; time and motion study; production control; and factory planning and layout.

A sequence of courses dealing with the financial control of an enterprise, including cost accounting, budgetary control, and standard costs.

A study of personnel management including hiring, training, rating, wages, wage incentives, and personnel relations.

A study of manufacturing processes by means of inspection trips and movies, including factory planning and materials handling.

A study of the history of scientific management.

##### Supplementary and Elective Subjects

Limited provision is made for elective subjects in the various fields of study where special circumstances or desires are indicated. Most of the courses given by the Industrial Engineering Department are supplemented by lectures from the conferences with prominent engineers and others in related fields.

All work given is predicated on the primary importance of fundamental engineering subjects, with the optimum additional coverage of subjects in the field of industrial engineering.

#### GRADUATE STUDIES

Graduate work in industrial engineering is offered as an opportunity for education on higher scientific and engineering levels than is possible in undergraduate study. Greater opportunities are thereby provided for specialization, for research and investigation, for independent work, and for meeting



Figure 3. By use of the conference technique, certain courses in industrial engineering bring home to the students the necessity for consultation and adequate discussion of industrial problems.

individual objectives. To encourage such study, a limited number of assistantships and fellowships have been created; these are awarded strictly on the basis of scholarship, research ability, and promise as a teacher.

Specific graduate courses now offered by this department include: factory planning; equipment selection and investment; advance materials handling; design of manufacturing enterprises; advanced motion and time study; transportation cost analysis; advanced engineering economy; sales engineering; job evaluation; wages, salaries, and incentives; quality control; advance production problems; and collective bargaining.

The enrollment in industrial engineering at Georgia Tech has increased over 800 per cent in less than a year and would be about double the present figure except for three factors: (1) Georgia Tech's lack of fully adequate facilities has suggested the wisdom of holding publicity to a minimum until space and additional faculty can be procured for the department, (2) although Georgia Tech has stretched its facilities almost to the breaking point to meet its obligations to the returning veterans and new graduates of Georgia high schools, the admission of several thousand students (chiefly from out-of-state) has had to be deferred, and (3) the department realizes that sound industrial engineering principles and practices are of great importance to the future of our democracy, hence has followed the policy of discouraging a student from taking this curriculum until he has sold the department on the proposition that it seems better for everybody concerned.

Although more than one hundred of the world's largest manufacturers are actively interested in Georgia Tech graduates in Industrial Engineering, it is disappointing to note that so few of these have home offices in the Southeast. It has been conservatively estimated that the State of Georgia could increase its income by more than one billion dollars a year through increased processing and manufacturing of its own raw materials into finished products.

The war is now over, as President Truman declared at noon on December 31, 1946. During the war period, industrial employment in the South was doubled, and during the same period industrial wages were increased to four times the prewar total for

this area. Industry, however, is now faced with a change from a "sellers' market" to a "buyers' market." Many manufacturers have been selling their products only because of a lack of competition from others. In spite of the many reconversion difficulties facing industry, enormous increases have been made in the total production of peace-time products. One outstanding example is in the radio field, where production reached 1,700,000 sets in August, 1946, compared with 1-100,000 in August of 1939. Can we maintain this increased production rate? Only if we can maintain the increased market by increased distribution.

To get this increased distribution, we need more sales and better transportation facilities. To maintain increased production and more sales, we must get better productivity. By increasing the productivity of men and machines, costs can be cut, thereby enabling more people to buy the products and thus creating a still greater demand, which in turn provides additional jobs for additional workers. This complex chain requires the cooperation of both management and labor, catalyzed by more and better industrial engineers and the application of modern industrial engineering.

In spite of many handicaps, Georgia Tech's new Department of Industrial Engineering is now in postwar production, turning out finished products. Only a few samples have been "graduated" during the past year, but by June of 1947 we will have thirty or forty of the new models which have cost their parents, this state, and the nation about \$40,000 each from the time of their conception to the date of their graduation.

Georgia industries and others who need these products will not have to repay this cost but can get the full use of them for a small rental charge (commonly known as salary), equal to approximately the legal rate of interest. Unlike many other products, our Georgia Tech products improve with age, and although not all of them will be able to save you as much as \$100,000 during the first year of use, some of them will. No plant is too small to use an industrial engineer, since he possesses a background of basic sciences and can be used in various capacities.

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*Continued on Page 23*

## DEVELOPMENT OF TECHNIQUES FOR WATER AND SEWAGE ANALYSIS

By GEORGE W. REID\*

*Last September, the Georgia School of Technology received one of the first nonmedical grants-in-aid ever made by the United States Public Health Service, providing funds for a three-year project on water and sewage analytical techniques. Preliminary work on this project is already under way, and this article describes the reasons for and importance of such research.*

Through the cooperation of the National Institute of Health; Dr. Thomas Parran, the Surgeon General of the United States; and the National Advisory Health Council, the new sanitary engineering branch of the Civil Engineering Department of the Georgia School of Technology has recently begun work on a research study of water and sew-

age analytical techniques. This program, which will require approximately three years for its completion, is also being jointly sponsored by the School, which has added \$5,000 to the \$15,000 granted by the United States Public Health Service for the first year's work.

Research in the field of water and sewage analysis is of particular interest and value (to the South and to the entire nation) be-

\*Associate Professor of Sanitary Engineering.



Figure 1. Modern equipment in the new sanitary engineering laboratory will be used in the development of water and sewage analytical techniques.

cause there exists a serious lack of adequate laboratory control in almost all small water and sewage plants. This condition is due, primarily, to the shortage of trained personnel and to the high expense of equipment required for performance of the standard analytical methods of the American Public Health Association. All too often, the sewage plant operator is not a technical man, although he is placed in charge of highly technical equipment and denied the right to employ competent assistants. Furthermore, even where some help is available, local conditions seem to prevent the increase of technicians' salaries to a level comparable to the responsibility required for economical operation of the plant, so that such positions continue to be underpaid.

Since this situation exists, the question naturally arises: can research succeed in simplifying and speeding up those tests necessary for adequate analysis of water to the point where a layman might conduct them? Experience in other fields has shown that physical tests can often be devised to replace chemical ones, thereby eliminating the necessity for the employment of a trained chemist. It therefore seems possible that new electronic and physical equipment might prove adaptable to simplifying the extensive tests used at the present. In addition, through further study, a workable system of special analytical methods might be developed which would fall within the limits of a single fundamental piece of equipment.

Such apparatus would be particularly adaptable to the small plant because on it one operator might perform all of his tests by such operations as adding a chemical indicator, reading a dial, etc., and then be able to adjust his treatment operation accordingly. The checking of instruments, calibrating of curves, and training of operators could be handled by state boards of health, thereby resulting in a highly desirable uniformity in reported results.

#### OTHER RAMIFICATIONS

Knowledge gained through such research on water and sewage analysis techniques will not be limited to these fields alone; the tests being studied are applicable also to field analysis in stream pollution surveys. Methods used at present require that the analytical equipment be carried from sampling sta-

tion to sampling station in the field being studied, regardless of the weather. In such studies, also, it is desirable to learn as much as possible about the stream's ecology at many different sampling points simultaneously. For these reasons, the utilization of a single, rapid technique and instrument would simplify the entire procedure and would, through lessened equipment expense and greater mobility, increase the number of samples measurable at one time. In addition, the avenue would be opened for the employment of subprofessional personnel.

Two other pertinent advantages which might result from this work are: (1) the more intimate control and efficient operation of large water and sewage treatment plants, and (2) increased utilization of tests which are now used infrequently because of present cumbersome procedures. The value of any control measures is decreased if a large time lag occurs between the time of the test and the time for various treatment (for purification, etc.). Any acceleration or short cuts developed in the tests now being used would naturally lessen this time lag and thereby increase the control exercised. For example, the best gauge used at present for sewage treatment is the B. O. D. test (for biological oxygen demand), but, since this test requires five days for completion, some of the value of control treatment based upon its results is lost during this time lag.

Study of some of these tests which are lengthy and complex, although very thorough, might result in simplified procedures which would be adaptable for speedy control measures. For example, the Kjeldahl test gives the complete nitrogen picture for water and sewage by testing for  $\text{NO}_2$ ,  $\text{NO}_3$ , etc., yet it is infrequently used because of the time required for its performance. Speculating a little, micro-Kjeldahl tests might prove adaptable and extremely saving in both time and laboratory space.

#### RESEARCH PLANS

Plans for research on this new project at Georgia Tech provide for the complete equipping of a laboratory in the new sanitary engineering section of the Department of Civil Engineering. Assisting the writer in this work will be Dr. Robert S. Ingols, Research Associate Professor of Sanitary

*Continued on Page 18*



## REPORT FROM THE LIBRARY

By DOROTHY M. CROSLAND\*

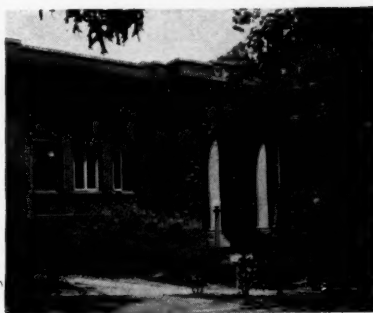
Our report was omitted from the last issue of THE RESEARCH ENGINEER because I was in Europe searching for journals and books for our library. As mentioned in the November issue, I had intended writing a report and sending it back to Mr. Weil, the editor, but it turned out that I was too busy, trying to cover as much territory as possible. I spent my days visiting libraries, book dealers, and publishers, and most of my nights were spent in making lists of my "Wants" for the dealers. Now that I am back at Tech, however, it might be interesting to record some of the events of my trip.

My mission was to purchase books and journals for our library, so that it will more adequately provide support for the research and graduate work that has been planned for our institution. Important files of journals and transactions of scientific and engineering societies that should have been in our library years ago are needed constantly by our faculty and research students. However, it is now almost impossible to find a complete file of any of these journals for sale, and one must take broken sets and hope to find the missing volumes later.

The assignment given me was not easy. I left Georgia Tech and the United States without really knowing whether I should return with one or many volumes. However, I did know that there were those at Tech who believed that such a journey as I was to make would reap rewards in many fields—and many valuable acquisitions have been made.

I travelled approximately 13,000 miles, visiting England, Scotland, Sweden, Denmark, Holland, Belgium, France, and Switzerland. In each of these countries, I visited some of the outstanding libraries and was fortunate enough to see some of the most wonderful scientific and technical collections in the world. The librarians, the faculties of the universities, the book dealers and publishers, and the people of the various countries were very gracious and kind to me—always offering and giving me help.

\*Librarian, Georgia School of Technology.



I shall remember always the Royal Society of London, where Mr. H. W. Robinson is Librarian. Here is one of the great scientific collections of the world. Complete files of all scientific societies, manuscripts that are priceless, and a collection on Sir Isaac Newton that has no equal make this library invaluable to a science scholar. What a thrill to see the manuscripts of Galileo, Newton, Boyle, Gibbs, and many other famous scientists!

At the Institution of Electrical Engineers, in London, I saw the notebooks of Michael Faraday and Oliver Heaviside—notebooks that were the background for Faraday's "Experimental Researches in Electricity" and "Researches in Chemistry and Physics" and Heaviside's "Electrical Papers and Electromagnetic Theory." This library is full of many valuable books and journals that have been contributed by its members. For one doing research in electricity, it is an invaluable storehouse, although unfortunately not all of the collection is catalogued.

The Institution of Civil Engineers and the Institution of Mechanical Engineers also have outstanding collections. Mr. Inglis, Librarian of the Institution of Civil Engineers, was most helpful and kind to me. Mr. Janson of the Science Museum Library can be justly proud of his collection, which comprises some 9,000 current journals and 350,000 books. The Patent Office Library seemed to have so many things that we want

at Tech—patents, books, journals—everything that seems so essential for research. Mr. W. E. White not only conducted me through this Library but also showed me some of its treasures, including the first patent issued in Great Britain to Thomas A. Edison for his phonograph, January 18, 1879.

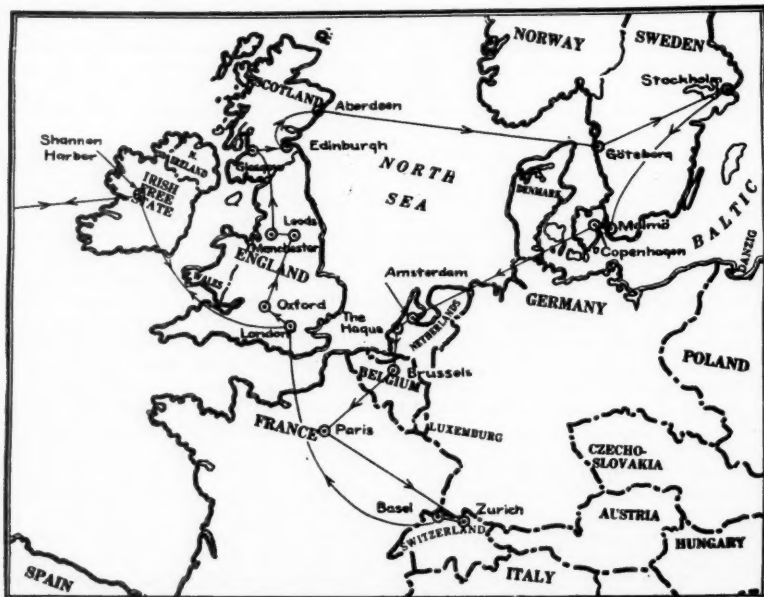
There were other great libraries in London, including the British Museum, that seemed to have all the journals I wanted to find and could not. However, very few of the books I needed were available for purchase, because most of the English book dealers had been bombed and their stocks completely destroyed. I went from one establishment to another, usually coming away with the same answer, "Sorry, we have so little in science and engineering. We shall be glad to have your list, however, and quote on any items we may locate for you."

There is another reason besides destroyed stocks to account for the shortage of books and journals in science and engineering. World War II pushed research and engineer-

ing to the front. Libraries which had never considered engineering seriously and libraries of newly established industries have bought heavily in the scientific and engineering fields. With destroyed libraries, newly established libraries, and the new interests of the world in which we are living, there has been a huge demand for books and journals in science and engineering, so that there are not enough to satisfy all the libraries. Some of us are more fortunate than others. Through book dealers, publishers, and librarians, I did make some valuable purchases in England and Scotland, and these volumes are now somewhere en route from London or have already arrived.

At Oxford, I was most fortunate in being allowed to see the new Bodleian Library. This building was particularly interesting since we hope sometime in the not-too-distant future to have a new library building of our own. The new one at Oxford is to be the storehouse for Old Bodleian, so that

*Continued on Page 20*



*Route of Mrs. Crosland's trip to Europe in search of library materials.*

## RECENT STATION PUBLICATIONS

## REPRINTS

Burrows, W. H., *Nomograph for Formulas Containing Fractional Exponents*. Georgia School of Technology, State Engineering Experiment Station Reprint No. 18, 1946. 4 pages. 25 cents.

This reprint of an article which appeared in *Industrial and Engineering Chemistry* describes the use of a nomograph for formulas containing fractional exponents. The use of such exponents in the derivation of empirical formulas is widespread in engineering fields, especially in chemical engineering, hydraulics, air conditioning, etc. However, empirical formulas are frequently encountered which require the simultaneous involution of terms to fractional powers and multiplication or division of several such terms.

These terms are cumbersome to handle by ordinary means, such as the log-log slide rule. To remedy this situation, a general nomograph has already been developed by McMillan<sup>1</sup>, providing a method of simultaneous involution and multiplication of such terms, but the new nomograph described in this reprint accomplishes the same results and generally requires fewer operations. Manipulation of the chart is therefore simpler.

At the same time, basic changes have been made which lead to greater accuracy of reading and interpolation of the scales and to a wider range of products. The method described is illustrated by the solution of a number of typical problems.

Hutchison, Dwight A., *Efficiency of the Electrolytic Separation of Potassium Isotopes*. Georgia School of Technology, State Engineering Experiment Station Reprint No. 19, 1946. 8 pages. 25 cents.

The electrolytic separation coefficient has been determined for the potassium isotope separation in the electrolysis of aqueous solutions of potassium chloride at a flowing mercury cathode. Suspension of purified potassium chloride crystals in a liquid mixture of bromoform, *n*-pentanol, and *n*-hexanol served as the analytical procedure in determining the isotopic composition of samples. Densities of the liquid suspension mixture as a function of temperature were independently determined.

As described in this reprint of an article from *The Journal of Chemical Physics*,

<sup>1</sup>McMillan, E. L., *Ind. Eng. Chem.* 30, 71 (1938).

the electrolytic separation factor for the potassium isotopes was found to be  $1.0054 \pm 0.0005$  for the temperature range of 15-50° C., and, within the limits of error, was independent of temperature, of the fraction electrolyzed, of the concentration of the electrolytic solution, of the current density, and of the amount of back reaction at the cathode. An empirical relation between the electrolytic separation factors of elements thus far investigated and their atomic weights is presented in this reprint.

Harper, John J., *Tests on Elbows of a Special Design*. Georgia School of Technology, State Engineering Experiment Station Reprint No. 20, 1946. 6 pages. 25 cents.

This reprint of an article which appeared in the *Journal of Aeronautical Sciences* presents the results of a series of tests on rectangular elbows of the type proposed by Szczeniowski. Six elbows were tested, including one conventional guide vane elbow designed in accordance with the recommendations in R. & M. No. 1773. Four of the special elbows had an aspect ratio (A. R.) of 0.67, while the fifth had an A. R. of 1.5.

The results show that under certain design conditions the special elbows show fewer losses than do conventional elbows with guide vanes. Increasing the aspect of the elbow reduces the losses.

## SPECIAL REPORTS

Hosmer, Joseph B., *The Need for More Peanut Processing Plants in Georgia* (Revised). State Engineering Experiment Station Special Report No. 22, 1947. 48 pages. 75 cents.

The conclusion expressed in the title that Georgia needs more peanut processing plants is based on an analysis of markets and a study of the ability of the Georgia peanut area to produce. The relationship between edible nut and oil uses is considered and the conclusion reached that food uses are more important for development than oil uses.

J. B. H.

Hosmer, Joseph B., *Georgia Opportunities for the Manufacture of More Paper*. State Engineering Experiment Station Special Report No. 24, 1947. 26 pages. 75 cents.

The three basic advantages which Georgia offers for paper manufacture—rapid growth of pine and plentiful supplies of kaolin and

rosin—are developed to account for the favorable statistical position for Georgia and the Southeast, shown by an analysis of Census of Manufacturers' data. This analysis includes most of the industry types (except printing and publishing) in which paper or pulp is used as a raw material. A list of paper mill locations in Georgia is also included.

It is estimated that the 1945 pulp production of 400,000 tons can be doubled without affecting other forest industries. The point that pulp manufacture without paper making is not advantageous to Georgia is emphasized by this report. J. B. H.

## ANALYTICAL TECHNIQUES

*Continued from Page 14*

Chemistry; Mrs. G. H. Murray, Research Assistant; and a number of graduate and student assistants. The laboratory work will involve the study of micro-methods, rapid and semi-quantitative procedures, and physical (as contrasted with chemical) methods of water and sewage analysis.

### LITERATURE SEARCH

Before the actual laboratory work is begun, however, an extensive literature survey is being prepared under the direction of Mr. B. H. Weil, chief of the Engineering Experiment Station's Technical Information Division, so that all available information will be at hand. Work to date has indicated the existence of at least 5,000 pertinent articles and bulletins. By September of this year, it is planned to have this material available in the form of a printed, classified bibliography, ready for use and for distribution to workers in this field.

Close examination of the literature already on hand indicates that, while considerable work on various methods and techniques for water and sewage analysis has already been performed, little or none of this work has had as its objectives the development of short-cut procedures productive of accurate results and designed to be usable by the average small water and sewage treatment plant, nor has it been particularly applicable to stream studies.

It is also evident that most of this previous work either predated the development of or did not take advantage of certain pieces of new electronic and physical equipment. Furthermore, present sewage test procedures indicate the need for increased application of fundamental research in the development of new tests. Although the work on water analysis methods has been more thorough, it has not been well correlated with plant control or field conditions.

### COOPERATING GROUPS

Many water and sewage plants have done some operational research, and the literature survey is being extended to canvass their unpublished tests and data, since a wealth of information on vocational and operational tests is known to be filed away in plant records.

After extensive laboratory research has been conducted on known fundamental techniques of analysis, such as micro-Kjeldahl, photometric, colorimetric, and spectroscopic methods as applied to water and sewage analysis, the results are to be examined under actual field conditions. In this connection the facilities of the Stream Sanitation Station of the United States Public Health Service in Cincinnati and the Atlanta Water Works and Sewage Treatment Plant will be available for field testing.

This project was established at Georgia Tech with the thought of developing one or several pieces of analytical equipment for use in all phases of testing—physical, chemical, and biological. To accomplish this in an effective manner, the Department of Sanitary Engineering at Johns Hopkins University has received a similar grant to conduct supplementary research on the biological phases of the project. This joint work is being conducted in consultation with Drs. Wolman, Geyer, and Renn of Johns Hopkins.

There exists a real need for quick and simplified methods of water and sewage analysis in small plant operations and stream pollution studies throughout the country. Any improvements in present methods will affect not only the work of a small, scientific group but also the welfare of the populace as a whole. This research on water and sewage analysis, therefore, is typical of scientific investigations which are putting fundamental and applied research to public use.

## RETAILER'S VIEWPOINT ON FROZEN FOODS

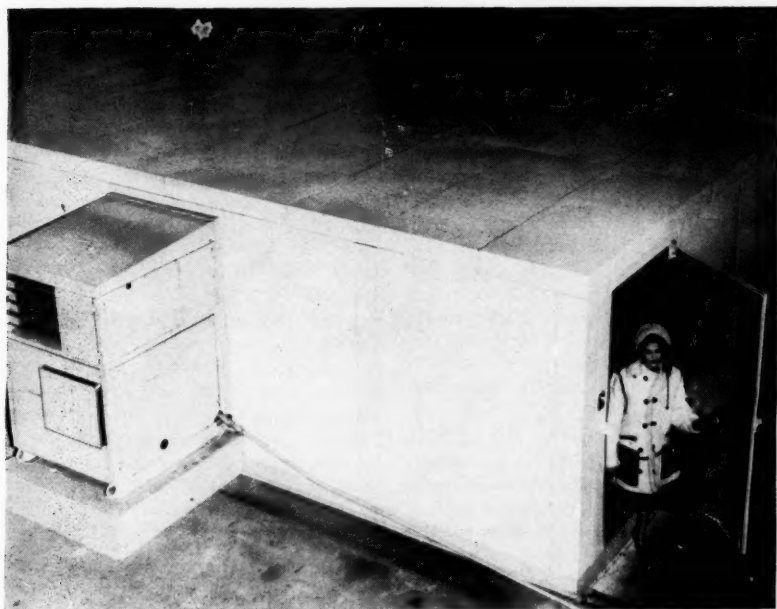
*Continued from Page 8*

ing unit or ice tray compartment. Home freezers, at present at least, are mainly located in farm and suburban areas, not in city apartments. However, if frozen foods sales are to expand greatly, more low-temperature storage space must be provided in the average home, so that the housewife can keep on hand a larger supply of frozen foods and therefore not run out so often.

The package must also contain complete cooking or handling directions, so that the housewife will know how to handle the specific product that she has purchased. The retailer does not have the time to explain to her just how to cook each package of food that she may purchase, any more than he has the time to tell a customer how long to roast a hen.

The quality of precooked dishes must be improved. The buying public must be convinced of their virtues if that aspect of the industry is to make progress. The economic advantages of large-scale cooking must be passed on to the consumer so that it will become cheaper for families to use such products, not more expensive as at present.

Meats account for a very large portion of the food dollar, and it is here that marked economics ought to be possible. Meat can be cut on a factory production line and the by-products efficiently used, thus resulting in lower unit prices. If the frozen meats were then marketed on a mass production basis, every small store could distribute meats even though it would normally be unprofitable to employ a butcher.



*Figure 2. Outside view of the refrigerated work room for frozen foods research at Georgia Tech.*

At present, those frozen meats which are available are too costly to meet the competition of fresh meats, besides having the disadvantage of being more complicated to cook. Therefore, lower prices plus more advertising plus general consumer education are vital if frozen meats are to attain national acceptance as staple items.

The demand for frozen foods, at present, is centered on seasonal fruits and vegetables, plus fish and poultry. These must have an advantage over the fresh or canned varieties if the consumer is to continue to buy them.

So the retailer asks for nation-wide advertising, for quality control, and for lower prices. He asks for a better type of package in more varied sizes, and with complete instructions on how to handle the contents. He wants self-service type cabinets of higher

quality, at lower prices if possible. He asks for cheaper electric current rates when he installs a number of frosted food cabinets.

Until a customer can walk into the corner grocery or the neighborhood supermarket and be certain of getting just the fruit or vegetable she wants, in an advertised brand name and at a reasonable price, frozen foods will not have firmly established themselves as profitable, staple items.

The independent grocer, the grocery chain, and the supermarket are not going to "push" frozen foods rather than canned goods or fresh produce. If frozen foods are to receive accelerated consumer acceptance, it will be because of increased efforts—research and advertising—on the part of producers and manufacturers, and because inexpensive home storage cabinets become plentifully available.

## REPORT FROM THE LIBRARY

*Continued from Page 16*

there is only one reading room in the new building, with a seating capacity for eighty, and most of the space is stacks and work rooms. It has been planned for storage for the next fifty years. The reading rooms for the students will be in the old building. There is an underground passage, book conveyors and lifts, tubes, and telephones connecting the buildings. I was shown also through the Radcliffe Science Library, which is a part of the Bodleian and is a new building, about twelve years old. My day at Oxford was most interesting.

It would be impossible to express my thanks to the friends I made at Leeds University, Leeds, England—Mr. Richard Offer, the Librarian; his assistant, Mr. S. Roberts; and members of the Textile Department, Dr. Whewell and Dr. Speakman. The Textile School of Leeds is outstanding, and this contact, I believe, is one of the most valuable ones that I made, because exchange relations were established with both the library and the Textile Department. Dr. Whewell very kindly gave me introductions

to the librarian of the Wool Institute in Leeds and to Mr. Ibbetson, the secretary of the Textile Institute in Manchester, where I had a very pleasant visit.

I found little to purchase in Scotland. I went to Glasgow, visiting the University, the Royal Technical College, Mitchell (the Municipal) Library, and the largest bookstores. In Edinburgh, I went to the University, the Heriot-Watt Technical Library, and more bookstores. I visited the King's College Library, Marischal (Engineering) College, and the Robert Gordon Technical College. Friends were made in all of these places, and the librarians, many professors, and book dealers now know that we want scientific books and journals. If any are available in the future, I shall be notified.

Following my excursions in England and Scotland, I then flew to Sweden. My experiences during the remainder of my journey made more and more friends for Georgia Tech. I shall tell you about the libraries on the continent in the next issue of THE RESEARCH ENGINEER.



## TVA RESEARCH ACTIVITIES

*Continued from Page 4*

periment Station, was completed with the publication of the report.

**Minerals Development**

TVA, state geology divisions, state institutions, and local miners and processors of minerals have cooperated to give impetus to the development of the Tennessee Valley mineral resources. In this program, the broad national knowledge of the U. S. Bureau of Mines and the U. S. Geological Survey is drawn upon, when required, for application to local problems. Attention is focused on the points to be solved by small operators, who are given access to otherwise unavailable technology in their efforts to develop the small and scattered deposits which occur in the region. The effectiveness of the collaboration of public agencies and businessmen is shown by frequent business application of information derived from the program, which has proved a practical method of getting public research into use.

**Northwest Georgia Mineral Resources**

Cooperating since December, 1943, with the Georgia Department of Mines, Mining and Geology, TVA, during the latter part of fiscal year 1946, has completed field surveys of the mineral resources of Northwest Georgia. This work was directed toward an appraisal of the possibilities in the area for industrial development and for increasing the economical utilization of minerals. Mineral deposits and operating mines were designated on base maps prepared from aerial photographs, together with contacts of geologic formations for the area of approximately 3,000 square miles which is included in the 10 counties of the northwest corner of the state. The data obtained have been transferred to a new base map which has been made on a scale of one inch to four miles.

This section of Georgia is an important producer of such minerals as barite, brown iron ore, manganese, and ocher. In recent years, there has been an increasing demand for detailed information as to locations of deposits of limestone suitable for agricultural and chemical uses. The information assem-

bled in this study constitutes a valuable basis upon which private business may rest decisions regarding contemplated enterprises.

**Grass Roots Laboratory Research**

The new North Carolina State College Minerals Laboratory, at Asheville, is furnishing TVA analyses and other determinations on mineral deposits in the eastern part of the Valley. This laboratory, under the direction of Dr. Jasper L. Stuckey, State Geologist, is giving valuable aid to mineral operators on ore preparation and beneficiation. It is an important new facility for the cooperative public research program being carried on in the region.

**Public Research at Work**

TVA has joined the Georgia Department of Mines, Mining, and Geology in prospecting the Hart-Elbert County area, where large samples of sillimanite were obtained. These samples were concentrated at the U. S. Bureau of Mines station at Tuscaloosa, Alabama, and the concentrates were shipped to the USBM laboratory at Norris, Tennessee, where they were processed into standardized firebricks which were then tested. It was determined that firebricks made with native sillimanite have good load resistance at high temperatures and meet standard reheat specifications. Since a mixture which gives satisfactory resistance to panel spalling or chipping has not been found, at least as yet, the study of this problem continues. The ceramic properties of the mineral are also being tested. If this native refractory mineral is to make a proper contribution to the economy of the region, this research—an appraisal of the resource for industrial use—is a necessary first step.

There are many instances in which the mining industry has been helped directly and immediately, although mineral development is essentially of a long range nature. The results to date indicate the soundness of the approach and probabilities of substantial future benefit to the region.

**AGRICULTURAL ENGINEERING**

TVA agricultural engineering activities are based on the need for equipment and

structures conducive to better farming in the Tennessee Valley. Thus the work of the Commerce Department's Agricultural Engineering Development Division supports broad Valley programs for conservation and development of farm lands. In addition, the division encourages fuller use of electricity on the farm through equipment developments and through an education program.

#### Farm Equipment

A score of machines for the farm and farm home have been built and demonstrated by TVA, working in cooperation with land grant colleges of the Valley.

Although the developments cover a wide range of uses, they all have a common objective; all are designed to contribute to Valley programs of farm readjustment and, in doing this, to fill the particular requirements of regional conditions; all are of relatively low cost; all are expected to induce greater productivity with less labor; and many are means of putting electricity profitably to use on the farm. These developments are also serving to call the attention of manufacturers to the need of the small farmer for mechanical assistance and to the feasibility of making equipment to supply him. They include a trailer thresher, developed cooperatively with the University of Tennessee (U.T.), which is being manufactured on a production line basis by a North Carolina firm and an Atlanta company.

This thresher is about half the size of the conventional threshing machine, but it performs efficiently on small and hilly farms over which it may be easily towed in trailer-fashion. Another University of Tennessee-TVA development is a seed scarifier which hastens germination in such hard-coated seed as that of the *sericea lespedeza*, an important cover crop. In cooperation with the agricultural experiment stations of Alabama, Georgia, Tennessee, and Virginia, TVA is introducing portable sprinkler systems, experiments with which indicate that field crops and pastures as well as many commercially grown fruits and vegetables may be irrigated profitably. A barn haydrier, which TVA developed in cooperation with the University of Tennessee, Virginia Polytechnic Institute, and the University of Georgia, preserves quality in hay and reduces loss caused by rain, sunburning, or bleaching in

field curing. An assembly of electric heating equipment for sweet potato curing and storage houses, devised by TVA and the Agricultural Experiment Station of the University of Tennessee, is being manufactured by a Tennessee Valley firm. A new kitchen flour mill will grind whole wheat into flour of any fineness and make corn meal, corn grits, and chicken feed. Among other TVA agricultural engineering developments are a kitchen pump-sink, an electric feed control for farm grinders, a ham aging cabinet, and a home food dehydrator. These research developments, along with others, are demonstrated in an educational program in cooperation with the educational agencies of the Valley states. Information as to their use is made available to farm youth and adult groups through 4-H clubs, vocational agricultural classes, demonstrations, meetings, tours, in-service training schools, and the like, and by means of published material.

After tests have showed the developments to operate satisfactorily, they are released to private manufacturers for production and distribution, making their contribution to industrial activity as they become available to farmers who will use them.

#### Farm Service Structures

The need for better farm structures, made clearer by neglect during the war and increased by the recent changes in and expansion of area farming, has placed stress on a program for the development of more efficient units for the farm factory.

The Valley farmer is becoming more aware of the waste occasioned by lack of storage facilities and that the adequate use of heat and refrigeration demand decided changes in the typical farm plants of the region. It has become apparent that low-cost farm structures adapted to southern climate conditions are needed for livestock and grain farming.

TVA, in addition to continuing its investigations on such subjects as sweet potato curing and storage houses, walk-in coolers, and barns equipped for drying hay, is broadening its studies to include farm service structures in general.

#### Full Value from Research

The Agricultural Engineering Development Division lends further support to the work of state colleges by helping rural peo-

ple gain access to research information on how to get full value from electricity, select farm machines best fitted to their needs, conserve soil and water by mechanical means, and improve the design of structures. This work has been going on in cooperation with the various land grant colleges of the Valley, including those in Georgia.

\* \* \* \*

These articles have described phases of the TVA program of service to the area and to the nation. Research and the application of its results are of equal importance to an effective program, and the four divisions of the Commerce Department of the Tennessee Valley Authority, working in behalf of commerce and industry in an integrated regional development program of the Tennessee Valley, are pledged to continue their efforts in both research on and development of regional resources.

## INDUSTRIAL ENGINEERING

*Continued from Page 12*

Georgia Tech probably now has the nation's largest enrollment in the field of industrial engineering, in spite of the serious handicaps which the department faces. Plans are well under way to provide a comprehensive schedule of evening classes to fill the needs for metropolitan Atlanta, and still other plans call for conferences of two to three weeks duration on subjects of general and specific interest to Georgia industries.

### RESEARCH PLANS

A considerable backlog of research problems has accumulated in the past few years in methods engineering, motion analysis, time study, micromotion study, plant layout, production control, and materials handling. Because of the great demand for industrial engineers in the fields of manufacturing and other industrial processes, however, the resulting shortage of personnel qualified to engage in industrial engineering research has become quite critical.

The Industrial Engineering Department at Georgia Tech has made preliminary studies of a number of these problems but has not yet engaged in detailed work on any of them,

because of the recency of its organization and the shortage of facilities, space, and personnel. Grants-in-aid have been requested for several projects, however, and every effort will be made to get research under way at the earliest possible moment. Departmental research plans call for each member of the faculty to have at least one research project under way at all times.

\* \* \* \*

Industrial engineering is a new field, but it is one of present and potential interest to industry in general. Efficient operation is today, more than ever, the keynote to industrial success, and industrial engineers are trained to cope with many of the problems involved in its attainment.

## INVENTION RECORDS

*Continued from Page 6*

temperature fluctuated," "the pressure varied," "the flask broke," etc., should be used.

### RECORD OF INVENTION

The important date in any research program is the date of conception. This is not *per se* the date on which the need or desirability of a mechanism or process was noted, but is instead the date on which the inventor or inventors thought of an effective way to accomplish the desired result. Much experimentation and "many sketches and perhaps some crude models" may have preceded this date, incidentally, "and all of these (records and models) should be preserved and dated."<sup>1</sup>

When an invention is thus clearly in mind, it is highly important that the inventor immediately prepare a "Record of Invention," stating in writing the problem and his proposed mode of attack, with all possible details and explanations, and accompanying this with such sketches as are needed to clarify the invention.

This formal record may be either in long-hand (in ink) or typed, with no corrections or with errors crossed out instead of erased; it is highly important that nothing be done that could lead to challenge at a later date. Single-spaced writing or typing should be employed, although double spacing between paragraphs is of course permissible. Each page should be numbered in the following

manner: "Page . . . of . . . Pages," the second figure being the total number of all pages including whatever drawings are incorporated in the record.

"The description should clearly state: (1) what the invention relates to, (2) the object of the invention, (3) what the different views in the (item-numbered) drawing show about the invention, (4) how the device is constructed, and (5) how it works."<sup>1</sup>

Caution should be exercised not to limit the invention unnecessarily; for example, if an electric motor is used in the present embodiment but any type of motor or driving mechanism could be employed, such terms as "use of driving means, such as an electric motor," prevent undue limitations. "The terms *means* and *device* are much used in patent work."<sup>2</sup>

If it is not possible to have the complete record of invention, including drawings, on one sheet, "the sheets should be permanently fastened together so that no one of them could be removed and another substituted" or, if this is not practical (as for typed pages), each page should be notarized or witnessed.

#### WITNESSING

The fact that a paper is dated is not legal evidence that that document existed on the date recorded and was then dated. In regard to the record of invention (and other important records), there are three methods of authenticating this date:

1. "Taking the written description and drawings to a notary public and having him attest them and attach his seal."<sup>1</sup>

2. Obtaining the signatures of two *qualified* persons who certify, above their signatures, that they "have examined the specification and the drawings pertaining thereto and fully understand the meaning thereof. Such witnesses should preferably not be members of the inventor's family or his business associates, and a witness who does not actually understand the invention may be of little use."<sup>2</sup>

3. "Folding each drawing and paper in such a manner that it can be sealed for mailing, without an envelope; addressing them all to oneself; and mailing them. The postmarks thus obtained are definite evidence that the drawings and descriptive matter were in evidence on the dates shown by the

postmarks. The seals should not be broken until the papers are needed as evidence.

"When the record is to be acknowledged by a notary public, a paragraph should be inserted between the description and the oath, giving as much as possible of the following information: (1) the date of original conception of the invention, (2) the date of the first drawing and the date of the first written description of the invention, (3) the date when the invention was first disclosed to others, (4) the date of reduction to practice of invention, and (5) the date when the inventor began actively exercising reasonable diligence in adapting and perfecting the invention."<sup>3</sup>

If a draftsman is employed in making the sketch or mechanical drawing, a statement to that effect should be signed and dated by this draftsman, testifying that he was so employed, that he disclaims being an inventor or coinventor, and that each drawing was completed on the date shown by him thereon.

Notebooks should be witnessed daily, weekly, or at regular periods by a qualified person (one capable of understanding the entries); when any record is of particular importance, however, two qualified individuals should witness it or a notary public should be employed.

\* \* \* \* \*

The inventor who wants to receive maximum benefit from his invention will prepare careful records; exercise reasonable diligence in completing his invention; take adequate precautions against premature disclosure and use; and, after his invention has been checked for novelty (by a search), will have his patent application prepared and filed by a reputable patent attorney. Only the observance of the "rules of the game" can guarantee that the inventive effort will not have proved in vain, no matter what the value of inventive concept.

#### BIBLIOGRAPHY

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